THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. IX.—No. 199.

UPON THE PRODUCTION OF SOUND BY RADIANT ENERGY.

By ALEXANDER GRAHAM BELL.

(A Paper read before the National Academy of Arts and Sciences, April 21st, 1881.)

IN a paper read before the American Association for the Advancement of Science, last August, I described certain experiments made by Mr. Sumner Tainter and myself which had resulted in the construction of a "Photophone," or apparatus for the production of sound by light;* and it will be my object to-day to describe the progress we have made in the investigation of photophonic phenomena since the date of this communication.

In my Boston paper the discovery was announced that thin discs of very many different substances *emitted sounds* when exposed to the action of a rapidly-interrupted beam of sun-light. The great variety of material used in these experiments led me to believe that sonorousness under such circumstances would be found to be a general property of all matter.

At that time we had failed to obtain audible effects from masses of the various substances which became sonorous in the condition of thin diaphragms, but this failure was explained upon the supposition that the molecular disturbance produced by the light was chiefly a surface action, and that under the circumstances of the experiments the vibration had to be transmitted through the mass of the substance in order to affect the ear. It was therefore supposed that, if we could lead to the ear air that was directly in contact with the illuminated surface, louder sounds might be obtained, and solid masses be found to be as sonorous as thin diaphragms. The first experiments made to verify this hypothesis pointed towards success. A beam of sunlight was focussed into one end of an open tube, the ear being placed at the other end. Upon interrupting the beam, a clear, musical tone was heard, the pitch of which depended upon the frequency of the interruption of the light and the loudness upon the material composing the tube.

At this stage our experiments were interrupted, as circumstances called me to Europe.

While in Paris a new form of the experiment occurred to my mind, which would not only enable us to investigate the sounds produced by masses, but would also permit us to test the more general proposition that *sonorousness, under the influence of intermittent light, is a property common to all matter.*

The substance to be tested was to be placed in the interior of a transparent vessel, made of some material which (like glass) is transparent to light, but practically opaque to sound.

Under such circumstances the light could get in, but the sound produced by the vibration of the substance could not get out. The audible effects could be studied by placing the ear in communication with the interior of the vessel by means of a hearing-tube.

Some preliminary experiments were made in Paris to test this idea, and the results were so promising that they were communicated to the French Academy on the 11th of October, 1880, in a note read for me by Mr. Antoine Breguet.* Shortly afterwards I wrote to Mr. Tainter, suggesting that he should carry on the investigation in America, as circumstances prevented me from doing so myself in Europe. As these experiments seem to have formed the common starting-point for a series of independent researches of the most important character, carried on simultaneously, in America by Mr. Tainter, and in Europe by M. Mercadier,† Prof. Tyndall,‡ W. E. Röntgen,§ and W. H. Preece,‖ I may be permitted to quote from my letter to Mr. Tainter the passage describing the experiments referred to:—

"Metropolitan Hotel, Rue Cambon, Paris,
"November 2nd, 1880.

"DEAR MR. TAINTER,—* * * I have devised a method of producing sounds by the action of an intermittent beam of light from substances that cannot be obtained in the shape of thin diaphragms or in the tubular form; indeed, the method is specially adapted to testing the generality of the phenomenon we have discovered, as it can be adapted to solids, liquids, and gases.

"Place the substance to be experimented with in a glass test-tube, connect a rubber tube with the mouth of the test-tube, placing the other end of the pipe to the ear. Then focus the intermittent beam upon the substance in the tube. I have tried a large number of substances in this way with great success, although it is extremely difficult to get a glimpse of the sun here, and when it does shine the intensity of the light is not to be compared with that to be obtained in Washington. I got splendid effects from crystals of bichromate of potash, crystals of sulphate of copper, and from tobacco smoke. A whole cigar placed in the test-tube produced a very loud sound. I could not hear anything from plain water, but when the water was discoloured with ink a feeble sound was heard. I would suggest that you might repeat these experiments and extend the results," &c., &c.

Upon my return to Washington in the early part of January,¶ Mr. Tainter communicated to me the results of the experiments he had made in my laboratory during my absence in Europe.

He had commenced by examining the sonorous properties of a vast number of substances inclosed in test-tubes in a simple empirical search for loud effects. He was thus led gradually to the discovery that cotton-wool, worsted, silk, and fibrous materials generally, produced much louder sounds than hard rigid bodies like crystals, or diaphragms such as we had hitherto used.

In order to study the effects under better circumstances he inclosed his materials in a conical cavity in

* *Proceedings of American Association for the Advancement of Science*, August 27, 1880; see, also, *American Journal of Science*, vol. xx. p. 305; *Journal of the American Electrical Society*, vol. iii, p. 3; *Journal of the Society of Telegraph Engineers and Electricians*, vol. ix. p. 404; *Annales de Chimie et de Physique*, vol. xxi.

* *Comptes Rendus*, vol. xci. p. 595.

† "Notes on Radiophony," *Comptes Rendus*, Dec. 6th and 13th, 1880; Feb. 21st and 28th, 1881. See also *Journal de Physique* vol. x. p. 53.

‡ "Action of an Intermittent Beam of Radiant Heat upon Gaseous Matter," *Proc. Royal Society*, Jan. 13th, 1881, vol. xxxi. p. 307.

§ "On the Tones which arise from the Intermittent Illumination of a Gas," see *Annalen der Phys. und Chemie*, Jan. 1881, No. 1, p. 155.

‖ "On the Conversion of Radiant Energy into Sonorous Vibrations," *Proc. Royal Society*, March 10th, 1881, vol. xxxi. p. 506.

¶ On the 7th of January.

a piece of brass closed by a flat plate of glass. A brass tube leading into the cavity served for connection with the hearing-tube. When this conical cavity was stuffed with worsted or other fibrous materials the sounds produced were much louder than when a test-tube was employed. This form of receiver is shown in fig. 1.

Mr. Tainter next collected silks and worsteds of different colours, and speedily found that the darkest shades produced the best effects. Black worsted especially gave an extremely loud sound.

As white cotton-wool had proved itself equal, if not superior, to any other white fibrous material before tried, he was anxious to obtain coloured specimens for comparison. Not having any at hand, however, he tried the effect of darkening some cotton-wool with lamp-black. Such a marked reinforcement of the sound resulted that he was induced to try lamp-black alone.

About a teaspoonful of lamp-black was placed in a test-tube and exposed to an intermittent beam of sunlight. The sound produced was much louder than any heard before.

Upon smoking a piece of plate-glass, and holding it in the intermittent beam with the lamp-black surface towards the sun, the sound produced was loud enough to be heard, with attention, in any part of the room. With the lamp-black surface turned from the sun the sound was much feebler.

Mr. Tainter repeated these experiments for me immediately upon my return to Washington, so that I might verify his results.

Upon smoking the interior of the conical cavity shown in fig. 1, and then exposing it to the intermittent beam, with the glass lid in position as shown, the effect was perfectly startling. The sound was so loud as to be actually painful to an ear placed closely against the end of the hearing-tube.

The sounds, however, were sensibly louder when we placed some smoked wire gauze in the receiver, as illustrated in the drawing, fig. 1.

When the beam was thrown into a resonator, the interior of which had been smoked over a lamp, most curious alternations of sound and silence were observed. The interrupting disc was set rotating at a high rate of speed, and was then allowed to come gradually to rest. An extremely feeble musical tone was at first heard, which gradually fell in pitch as the rate of interruption grew less. The loudness of the sound produced varied in the most interesting manner. Minor reinforcements were constantly occurring, which became more and more marked as the true pitch of the resonator was neared. When at last the frequency of interruption corresponded to the frequency of the fundamental of the resonator, the sound produced was so loud that it might have been heard by an audience of hundreds of people.

The effects produced by lamp-black seemed to me to be very extraordinary, especially as I had a distinct recollection of experiments made in the summer of 1880 with smoked diaphragms, in which no such reinforcement was noticed.

Upon examining the records of our past photophonic experiments we found in vol. vii., p. 57, the following note:—

"Experiment V.—Mica diaphragm covered with lamp-black on side exposed to light.

"Result: distinct sound, about same as without lamp-black.—A. G. B., July 18th, 1880.

"Verified the above, but think it somewhat louder than when used without lamp-black.—S. T., July 18th, 1880."

Upon repeating this old experiment we arrived at the same result as that noted. Little if any augmentation of sound resulted from smoking the mica. In this experiment the effect was observed by placing the mica diaphragm against the ear and also by listening through a hearing-tube one end of which was closed by the diaphragm. The sound was found to be more audible through the free air when the ear was placed as near to the lamp-black surface as it could be brought without shading it.

At the time of my communication to the American Association I had been unable to satisfy myself that the substances which had become sonorous under the direct influence of intermittent sunlight were capable of reproducing the sounds of articulate speech under the action of an undulatory beam from our photophonic transmitter. The difficulty in ascertaining this will be understood by considering that the sounds emitted by thin diaphragms and tubes were so feeble that it was impracticable to produce audible effects from substances in these conditions at any considerable distance away from the transmitter; but it was equally impossible to judge of the effects produced by our articulate transmitter at a short distance away because the speaker's voice was directly audible through the air. The extremely loud sounds produced from lamp-black have enabled us to demonstrate the feasibility of using this

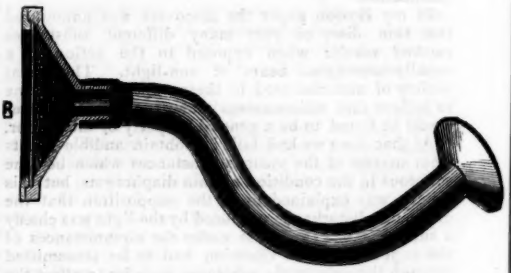


FIG. 1.

substance in an articulating photophone in place of the electrical receiver formerly employed.

The drawing, fig. 2, illustrates the mode in which the experiment was conducted. The diaphragm of the transmitter, A, was only 5 centimetres in diameter, the diameter of the receiver, B, was also 5 centimetres, and the distance between the two was 40 metres, or 800 times the diameter of the transmitting diaphragm. We were unable to experiment at greater distances without a heliostat on account of the difficulty of keeping the light steadily directed on the receiver. Words and sentences spoken into the transmitter in a low tone of voice were audibly reproduced by the lamp-black receiver.

In fig. 3 is shown a mode of interrupting a beam of sunlight for producing distant effects without the use of lenses. Two similarly-perforated discs are employed, one of which is set in rapid rotation, while the other remains stationary. This form of interrupter is also admirably adapted for work with artificial light. The receiver illustrated in the drawing consists of a parabolic reflector, in the focus of which is placed a glass vessel, A, containing lamp-black or other sensitive substance, and connected with a hearing-tube. The beam of light is interrupted by its passage through the two slotted discs shown at B, and in operating the instrument musical signals like the dots and dashes of the Morse alphabet are produced from the sensitive

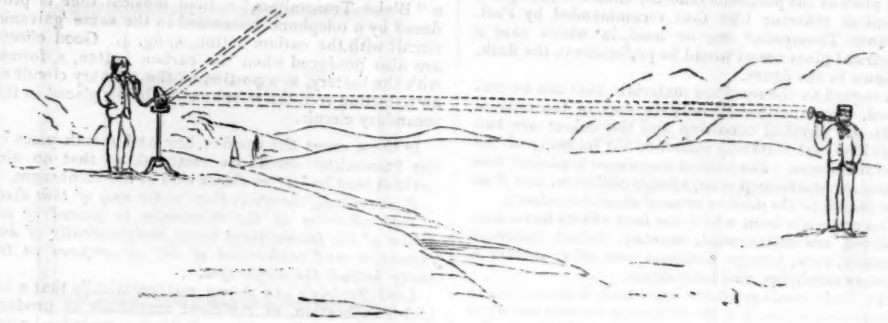
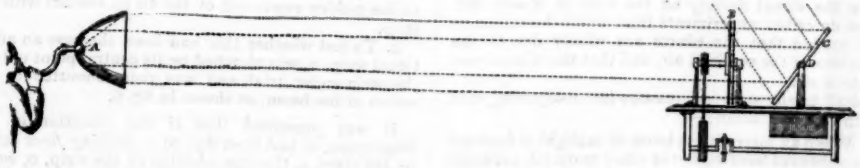


FIG. 2.

FIG. 3.



receiver, A, by slight motions of the mirror, C, about its axis, D.

In place of the parabolic reflector shown in the figure, a conical reflector like that recommended by Prof. Sylvanus Thompson* can be used, in which case a cylindrical glass vessel would be preferable to the flask, A, shown in the figure.

In regard to the sensitive materials that can be employed, our experiments indicate that in the case of solids the physical condition and the colour are two conditions that markedly influence the intensity of the sonorous effects. *The loudest sounds are produced from substances in a loose, porous, spongy condition, and from those that have the darkest or most absorbent colours.*

The materials from which the best effects have been produced are cotton-wool, worsted, fibrous materials generally, cork, sponge, platinum and other metals in a spongy condition, and lamp-black.

The loud sounds produced from such substances may perhaps be explained in the following manner:—Let us consider, for example, the case of lamp-black—a substance which becomes heated by exposure to rays of all refrangibility. I look upon a mass of this substance as a sort of sponge, with its pores filled with air instead of water. When a beam of sunlight falls upon this mass, the particles of lamp-black are heated, and consequently expand, causing a contraction of the air-spaces or pores among them.

Under these circumstances a pulse of air should be expelled, just as we would squeeze out water from a sponge.

The force with which the air is expelled must be greatly increased by the expansion of the air itself, due to contact with the heated particles of lamp-black. When the light is cut off the converse process takes place. The lamp-black particles cool and contract, thus enlarging the air-spaces among them, and the inclosed air also becomes cool. Under these circumstances a partial vacuum should be formed among the particles, and the outside air would then be absorbed, as water is by a sponge when the pressure of the hand is removed.

I imagine that in some such manner as this a wave of condensation is started in the atmosphere each time a beam of sunlight falls upon lamp-black, and a wave of rarefaction is originated when the light is cut off. *We can thus understand how it is that a substance like lamp-black produces intense sonorous vibrations in the surrounding air, while at the same time it communicates a very feeble vibration to the diaphragm or solid bed upon which it rests.*

This curious fact was independently observed in England by Mr. Preece, and it led him to question whether, in our experiments with thin diaphragms, the sound heard was due to the vibration of the disc or (as Prof. Hughes had suggested) to the expansion and contraction of the air in contact with the disc confined in the cavity behind the diaphragm. In his paper read before the Royal Society on the 10th of March, Mr. Preece describes experiments from which he claims to have proved that the effects are wholly due to the vibrations of the confined air, and that the *discs do not vibrate at all.*

I shall briefly state my reasons for disagreeing with him in this conclusion:—

1. When an intermittent beam of sunlight is focussed upon a sheet of hard rubber or other material, a musical tone can be heard, not only by placing the ear immediately behind the part receiving the beam, but by placing it against any portion of the sheet, even though this may be a foot or more from the place acted upon by the light.

2. When the beam is thrown upon the diaphragm of a "Blake Transmitter," a loud musical tone is produced by a telephone connected in the same galvanic circuit with the carbon button, A, fig. 4. Good effects are also produced when the carbon button, A, forms, with the battery, B, a portion of the primary circuit of an induction coil, the telephone, C, being placed in the secondary circuit.

In these cases the wooden box and mouth-piece of the transmitter should be removed, so that no air-cavities may be left on either side of the diaphragm.

It is evident, therefore, that in the case of thin discs a real vibration of the diaphragm is caused by the action of the intermittent beam, independently of any expansion and contraction of the air confined in the cavity behind the diaphragm.

Lord Rayleigh has shown mathematically that a to-and-fro vibration, of sufficient amplitude to produce an audible sound, would result from a periodical communication and abstraction of heat, and he says: "We may conclude, I think, that there is at present no reason for discarding the obvious explanation that the sounds in question are due to the bending of the plates under unequal heating." (*Nature*, xxiii., p. 274.) Mr. Preece, however, seeks to prove that the sonorous effects cannot be explained upon this supposition; but his experimental proof is inadequate to support his conclusion. Mr. Preece expected that if Lord Rayleigh's explanation was correct, the expansion and contraction of a thin strip under the influence of an intermittent beam could be caused to open and close a galvanic circuit so as to produce a musical tone from a telephone in the circuit. But this was an inadequate way to test the point at issue, for Lord Rayleigh has shown (*Proc. of Roy. Soc.*, 1877) that an audible sound can be produced by a vibration whose amplitude is *less than a ten-millionth of a centimetre*, and certainly such a vibration as that would not have sufficed to operate a "make-and-break contract" like that used by Mr. Preece. The negative results obtained by him cannot, therefore, be considered conclusive.

The following experiments (devised by Mr. Tainter) have given results decidedly more favourable to the theory of Lord Rayleigh than to that of Mr. Preece:—

1. A strip, A, similar to that used in Mr. Preece's experiment, was attached firmly to the centre of an iron diaphragm, B, as shown in fig. 5, and was then pulled taut at right angles to the plane of the diaphragm. When the intermittent beam was focussed upon the strip, A, a clear musical tone could be heard by applying the ear to the hearing-tube, C.

This seemed to indicate a rapid expansion and contraction of the substance under trial.

But a vibration of the diaphragm, B, would also have resulted if the thin strip, A, had acquired a to-and-fro motion, due either to the direct impact of the beam or to the sudden expansion of the air in contact with the strip.

2. To test whether this had been the case an additional strip, D, was attached by its central point only to the strip under trial, and was then submitted to the action of the beam, as shown in fig. 6.

It was presumed that if the vibration of the diaphragm, B, had been due to a *pushing force* acting on the strip, A, that the addition of the strip, D, would not interfere with the effect. But if, on the other hand, it had been due to the longitudinal expansion and contraction of the strip, A, the sound would cease, or at least be reduced. The beam of light falling upon strip, D, was now interrupted as before by the rapid

* *Phil. Mag.*, April, 1881, vol. xi. p. 286.

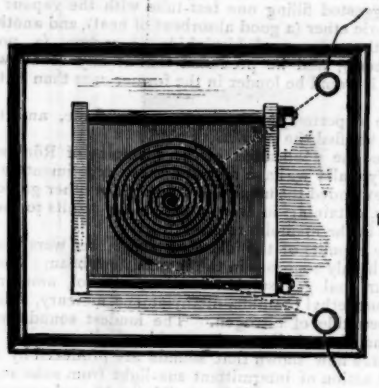


FIG. 7.

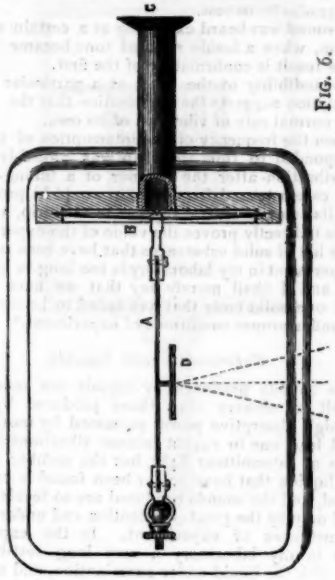


FIG. 6.

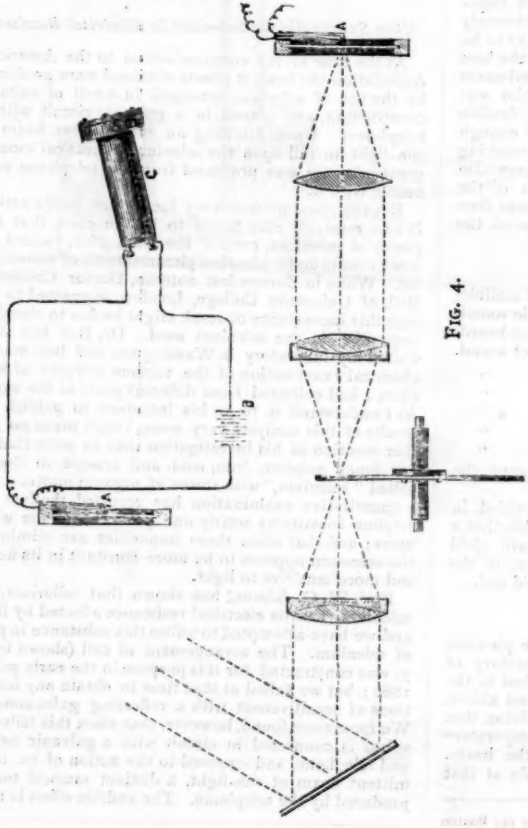


FIG. 4.

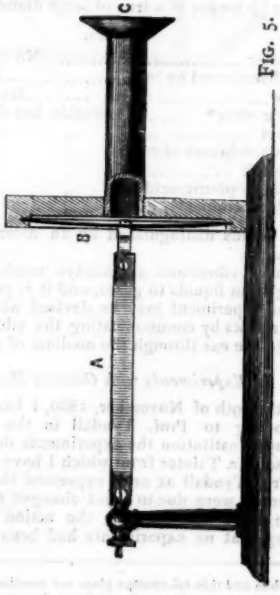


FIG. 5.

rotation of a perforated disc, which was allowed to come gradually to rest.

No sound was heard excepting at a certain speed of rotation, when a feeble musical tone became audible.

This result is confirmatory of the first.

The audibility of the effect at a particular rate of interruption suggests the explanation that the strip, D, had a normal rate of vibration of its own.

When the frequency of the interruption of the light corresponded to this, the strip was probably thrown into vibration after the manner of a tuning-fork, in which case a to-and-fro vibration would be propagated down its stem or central support to the strip, A.

This indirectly proves the value of the experiment.

The list of solid substances that have been submitted to experiment in my laboratory is too long to be quoted here, and I shall merely say that we have not yet found one solid body that has failed to become sonorous under proper conditions of experiment.*

Experiments with Liquids.

The sounds produced by liquids are much more difficult to observe than those produced by solids. The high absorptive power possessed by most liquids would lead one to expect intense vibrations from the action of intermittent light, but the number of sonorous liquids that have so far been found is extremely limited, and the sounds produced are so feeble as to be heard only by the greatest attention and under the best circumstances of experiment. In the experiments made in my laboratory a very long test-tube was filled with the liquid under examination, and a flexible rubber-tube was slipped over the mouth far enough down to prevent the possibility of any light reaching the vapour above the surface. Precautions were also taken to prevent reflection from the bottom of the test-tube. An intermittent beam of sun-light was then focussed upon the liquid in the middle portion of the test-tube by means of a lens of large diameter.

Results.

Clear water	No sound audible.
Water discoloured by ink	Feeble sound.
Mercury	No sound heard.
Sulphuric ether*	Feeble, but distinct sound.
Ammonia	" " "
Ammonia-sulphate of copper	" " "
Writing ink	" " "
Indigo in sulphuric acid	" " "
Chloride of copper*	" " "

The liquids distinguished by an asterisk gave the best sounds.

Acoustic vibrations are always much enfeebled in passing from liquids to gases, and it is probable that a form of experiment may be devised which will yield better results by communicating the vibrations of the liquid to the ear through the medium of a solid rod.

Experiments with Gaseous Matter.

On the 29th of November, 1880, I had the pleasure of showing to Prof. Tyndall in the laboratory of the Royal Institution the experiments described in the letter to Mr. Tainter from which I have quoted above, and Prof. Tyndall at once expressed the opinion that the sounds were due to rapid changes of temperature in the body submitted to the action of the beam. Finding that no experiments had been made at that time to test the sonorous properties of different gases, he suggested filling one test-tube with the vapour of sulphuric ether (a good absorbent of heat), and another with the vapour of bisulphide of carbon (a poor absorbent), and he predicted that if any sound was heard it would be louder in the former case than in the latter.

The experiment was immediately made, and the result verified the prediction.

Since the publication of the memoirs of Röntgen* and Tyndall† we have repeated these experiments, and have extended the inquiry to a number of other gaseous bodies, obtaining in every case similar results to those noted in the memoirs referred to.

The vapours of the following substances were found to be highly sonorous in the intermittent beam: Water vapour, coal gas, sulphuric ether, alcohol, ammonia, amylene, ethyl bromide, diethylamene, mercury, iodine, and peroxide of nitrogen. The loudest sounds were obtained from iodine and peroxide of nitrogen.

I have now shown that sounds are produced by the direct action of intermittent sun-light from substances in every physical condition (solid, liquid, and gaseous), and the probability is therefore very greatly increased that sonorousness under such circumstances will be found to be a universal property of matter.

Upon Substitutes for Selenium in Electrical Receivers.

At the time of my communication to the American Association the loudest effects obtained were produced by the use of selenium, arranged in a cell of suitable construction, and placed in a galvanic circuit with a telephone. Upon allowing an intermittent beam of sun-light to fall upon the selenium a musical tone of great intensity was produced from the telephone connected with it.

But the selenium was very inconstant in its action. It was rarely, if ever found to be the case, that two pieces of selenium, even of the same stick, yielded the same results under identical circumstances of annealing, &c. While in Europe last autumn, Doctor Chichester Bell, of University College, London, suggested to me that this inconstancy of result might be due to chemical impurities in the selenium used. Dr. Bell has since visited my laboratory in Washington, and has made a chemical examination of the various samples of selenium I had collected from different parts of the world. As I understand it to be his intention to publish the results of this analysis very soon, I shall make no further mention of his investigation than to state that he has found sulphur, iron, lead, and arsenic in the so-called "selenium," with traces of organic matter; that a quantitative examination has revealed the fact that sulphur constitutes nearly one per cent. of the whole mass; and that when these impurities are eliminated the selenium appears to be more constant in its action and more sensitive to light.

Prof. W. G. Adams‡ has shown that tellurium, like selenium, has its electrical resistance affected by light, and we have attempted to utilise this substance in place of selenium. The arrangement of cell (shown in fig. 7) was constructed for this purpose in the early part of 1880; but we failed at that time to obtain any indications of sensitiveness with a reflecting galvanometer. We have since found, however, that when this tellurium spiral is connected in circuit with a galvanic battery and telephone, and exposed to the action of an intermittent beam of sun-light, a distinct musical tone is produced by the telephone. The audible effect is much

* Carbon and thin microscope glass are mentioned in my Boston paper as non-responsive, and powdered chlorate of potash in the communication to the French Academy (*Comptes Rendus*, vol. xci. p. 595). All these substances have since yielded sounds under more careful conditions of experiment.

* *Ann. der Phys. und Chem.*, 1881, No. 1, p. 155.
† *Proc. Roy. Soc.*, vol. xxxi. p. 307.
‡ *Proc. Roy. Soc.*, vol. xxiv. p. 163.

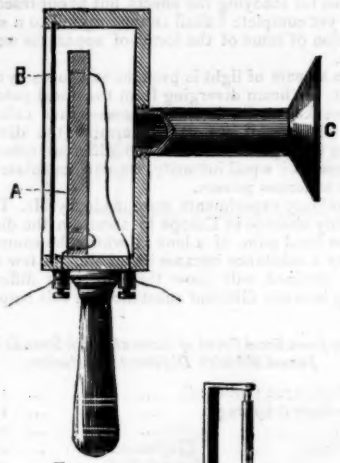


FIG. 9.

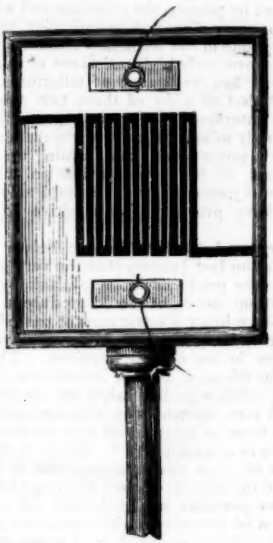


FIG. 8.

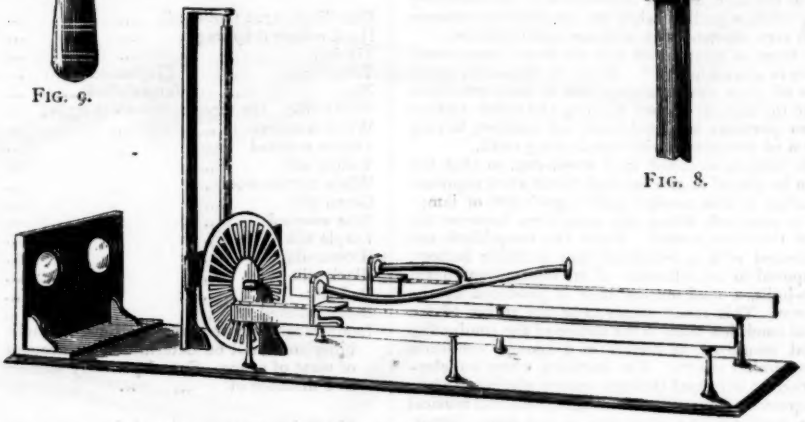
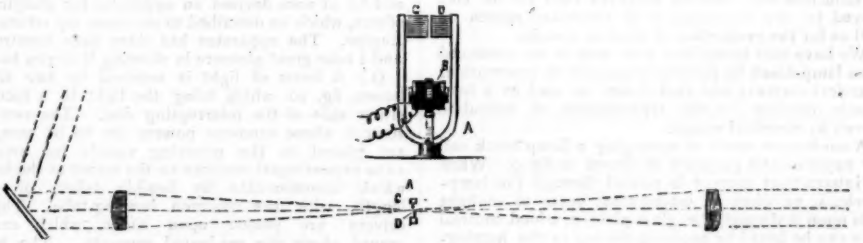


FIG. 10.



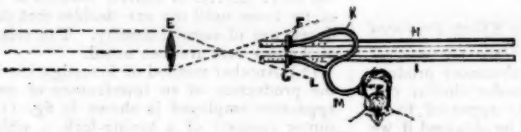


FIG. 11.

increased by placing the tellurium cell with the battery in the primary circuit of an induction coil, and placing the telephone in the secondary circuit.

The enormously high resistance of selenium and the extremely low resistance of tellurium suggested the thought that an alloy of these two substances might possess intermediate electrical properties. We have accordingly mixed together selenium and tellurium in different proportions, and while we do not feel warranted at the present time in making definite statements concerning the results, I may say that such alloys have proved to be sensitive to the action of light.

It occurred to Mr. Tainter before my return to Washington last January that the very great molecular disturbance produced in lamp-black by the action of intermittent sun-light should produce a corresponding disturbance in an electric current passed through it, in which case lamp-black could be employed in place of selenium in an electric receiver. This has turned out to be the case, and the importance of the discovery is very great, especially when we consider the expense of such rare substances as selenium and tellurium.

The form of lamp-black cell we have found most effective is shown in fig. 8. Silver is deposited upon a plate of glass, and a zigzag line is then scratched through the film, as shown, dividing the silver surface into two portions insulated from one another, having the form of two combs with interlocking teeth.

Each comb is attached to a screw-cup, so that the cell can be placed in an electrical circuit when required. The surface is then smoked until a good film of lamp-black is obtained, filling the interstices between the teeth of the silver combs. When the lamp-black cell is connected with a telephone and galvanic battery, and exposed to the influence of an intermittent beam of sun-light, a loud musical tone is produced by the telephone. This result seems to be due rather to the physical condition than to the nature of the conducting material employed, as metals in a spongy condition produce similar effects. For instance, when an electrical current is passed through spongy platinum while it is exposed to intermittent sun-light, a distinct musical tone is produced by a telephone in the same circuit. In all such cases the effect is increased by the use of an induction coil; and the sensitive cells can be employed for the reproduction of articulate speech as well as for the production of musical sounds.

We have also found that loud sounds are produced from lamp-black by passing through it an intermittent electrical current; and that it can be used as a telephonic receiver for the reproduction of articulate speech by electrical means.

A convenient mode of arranging a lamp-black cell for experimental purposes is shown in fig. 9. When an intermittent current is passed through the lamp-black, A, or when an intermittent beam of sunlight falls upon it through the glass plate, B, a loud musical tone can be heard by applying the ear to the hearing-tube, C. When the light and the electrical current act simultaneously, two musical tones are perceived, which produce beats when nearly of the same pitch. By proper arrangements a complete interference of sound can undoubtedly be produced.

Upon the Measurement of the Sonorous Effects Produced by Different Substances.

We have observed that different substances produce sounds of very different intensities under similar circumstances of experiment, and it has appeared to us that very valuable information might be obtained if we could measure the audible effects produced. For this purpose we have constructed several different forms of apparatus for studying the effects, but as our researches are not yet complete I shall confine myself to a simple description of some of the forms of apparatus we have devised.

When a beam of light is brought to a focus by means of a lens, the beam diverging from the focal point becomes weaker as the distance increases in a calculable degree. Hence, if we can determine the distances from the focal point at which two different substances emit sounds of equal intensity, we can calculate their relative sonorous powers.

Preliminary experiments were made by Mr. Tainter during my absence in Europe to ascertain the distance from the focal point of a lens at which the sound produced by a substance became inaudible. A few of the results obtained will show the enormous differences existing between different substances in this respect.

Distance from Focal Point of Lens at which Sounds become Inaudible with Different Substances.

Zinc diaphragm (polished)	1·51 m.
Hard rubber diaphragm	1·90 „
Tin-foil „	2·00 „
Telephone „ (Japanned iron) ...	2·15 „
Zinc „ (unpolished)... ...	2·15 „
White silk. (In receiver shown in fig. 1) ...	3·10 „
White worsted „ „ ...	4·01 „
Yellow worsted „ „ ...	4·06 „
Yellow silk „ „ ...	4·13 „
White cotton-wool „ „ ...	4·38 „
Green silk „ „ ...	4·52 „
Blue worsted „ „ ...	4·69 „
Purple silk „ „ ...	4·82 „
Brown silk „ „ ...	5·02 „
Black silk „ „ ...	5·21 „
Red silk „ „ ...	5·24 „
Black worsted „ „ ...	6·50 „
Lamp-black. In receiver the limit of audibility could not be determined on account of want of space. Sound perfectly audible at a distance of	10·00 „

Mr. Tainter was convinced from these experiments that this field of research promised valuable results, and he at once devised an apparatus for studying the effects, which he described to me upon my return from Europe. The apparatus has since been constructed, and I take great pleasure in showing it to you to-day.

(1.) A beam of light is received by two similar lenses, fig. 10, which bring the light to a focus on either side of the interrupting disc. The two substances whose sonorous powers are to be compared are placed in the receiving vessels (so arranged as to expose equal surfaces to the action of the beam), which communicate by flexible tubes, of equal length, with the common hearing-tube. The receivers are placed upon slides, which can be moved along the graduated supports. The beams of light passing through the interrupting disc are alternately cut off by the swinging of a pendulum. Thus a musical tone is produced. One of the receivers is kept at a constant point upon its scale, and the other receiver is moved towards or from the focus of its beam until the ear decides that the sounds produced are of equal intensity. The relative positions of the receivers are then noted.

(2.) Another method of investigation is based upon the production of an interference of sound, and the apparatus employed is shown in fig. 11. The interrupter consists of a tuning-fork, A, which is kept in continuous vibration by means of an electro-magnet, B.

A powerful beam of light is brought to a focus

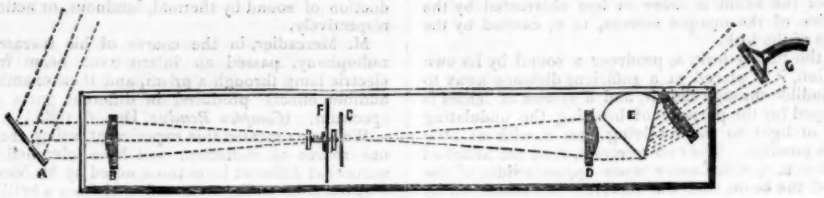


FIG 12.

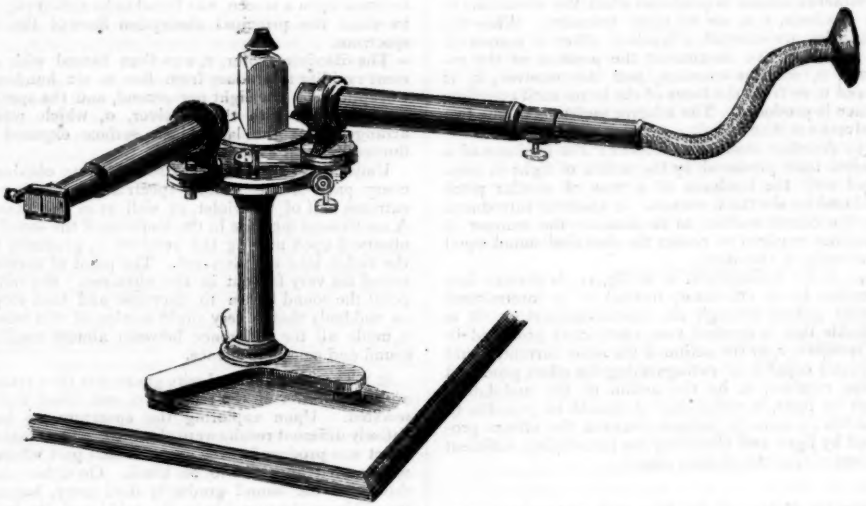


FIG. 13.

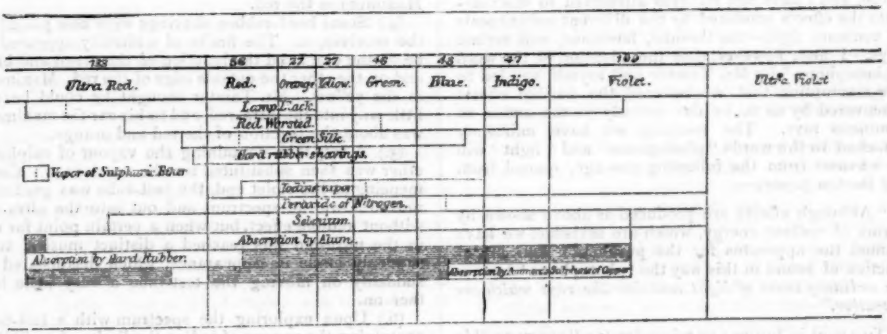


FIG. 14.

between the prongs of the tuning-fork, A, and the passage of the beam is more or less obstructed by the vibration of the opaque screens, C, D, carried by the prongs of the fork.

As the tuning-fork, A, produces a sound by its own vibration, it is placed at a sufficient distance away to be inaudible through the air, and a system of lenses is employed for the purpose of bringing the undulating beam of light to the receiving lens, E, with as little loss as possible. The two receivers, F, G, are attached to slides, H, I, which move upon opposite sides of the axis of the beam, and the receivers are connected by flexible tubes of unequal length, K, L, communicating with the common hearing-tube, M.

The length of the tube, K, is such that the sonorous vibrations from the receivers, F, G, reach the common hearing-tube, M, in opposite phases. Under these circumstances silence is produced when the vibrations in the receivers, F, G, are of equal intensity. When the intensities are unequal, a residual effect is perceived. In operating the instrument the position of the receiver, G, remains constant, and the receiver, F, is moved to or from the focus of the beam until complete silence is produced. The relative positions of the two receivers are then noted.

(3.) Another mode is as follows: The loudness of a musical tone produced by the action of light is compared with the loudness of a tone of similar pitch produced by electrical means. A rheostat introduced into the circuit enables us to measure the amount of resistance required to render the electrical sound equal in intensity to the other.

(4.) If the tuning-fork, A, in fig. 11, is thrown into vibration by an undulatory instead of an intermittent current passed through the electro-magnet, B, it is probable that a musical tone, electrically produced in the receiver, F, by the action of the same current, would be found capable of extinguishing the effect produced in the receiver, G, by the action of the undulatory beam of light, in which case it should be possible to establish an acoustic balance between the effects produced by light and electricity by introducing sufficient resistance into the electric circuit.

Upon the Nature of the Rays that produce Sonorous Effects in Different Substances.

In my paper read before the American Association last August, and in the present paper, I have used the word "light" in its usual rather than its scientific sense, and I have not hitherto attempted to discriminate the effects produced by the different constituents of ordinary light—the thermal, luminous, and actinic rays. I find, however, that the adoption of the word "photophone" by Mr. Tainter and myself has led to the assumption that we believed the audible effects discovered by us to be due entirely to the action of luminous rays. The meaning we have uniformly attached to the words "photophone" and "light" will be obvious from the following passage, quoted from my Boston paper:—

"Although effects are produced as above shown by forms of radiant energy, which are invisible, we have named the apparatus for the production and reproduction of sound in this way the 'photophone' *because an ordinary beam of light contains the rays which are operative.*"

To avoid in future any misunderstandings upon this point we have decided to adopt the term "*radiophone*," proposed by M. Mercadier, as a general term signifying an apparatus for the production of sound by any form of radiant energy, limiting the words *thermophone*, *photophone*, and *actinophone*, to apparatus for the production of sound by thermal, luminous, or actinic rays respectively.

M. Mercadier, in the course of his researches in radiophony, passed an intermittent beam from an electric lamp through a prism, and then examined the audible effects produced in different parts of the spectrum. (*Comptes Rendus*, Dec. 6, 1880.)

We have repeated this experiment, using the sun as our source of radiation, and have obtained results somewhat different from those noted by M. Mercadier.

A beam of sunlight was reflected from a heliostat, A, fig. 12, through an achromatic lens, B, so as to form an image of the sun upon the slit, C.

The beam then passed through another achromatic lens, D, and through a bisulphide of carbon prism, E, forming a spectrum of great intensity, which, when focussed upon a screen, was found to be sufficiently pure to show the principal absorption lines of the solar spectrum.

The disc-interrupter, F, was then turned with sufficient rapidity to produce from five to six hundred interruptions of the light per second, and the spectrum was explored with the receiver, G, which was so arranged that the lamp-black surface exposed was limited by a slit as shown.

Under these circumstances sounds were obtained in every part of the visible spectrum, excepting the extreme half of the violet, as well as in the ultra-red. A continuous increase in the loudness of the sound was observed upon moving the receiver, G, gradually from the violet into the ultra-red. The point of maximum sound lay very far out in the ultra-red. Beyond this point the sound began to decrease, and then stopped so suddenly that a very slight motion of the receiver, G, made all the difference between almost maximum sound and complete silence.

(2.) The lamp-blacked wire gauze was then removed and the interior of the receiver, G, was filled with red worsted. Upon exploring the spectrum as before entirely different results were obtained. The maximum effect was produced in the green at that part where the red worsted appeared to be black. On either side of this point the sound gradually died away, becoming inaudible on the one side in the middle of the indigo, and on the other at a short distance outside the edge of the red.

(3.) Upon substituting green silk for red worsted the limits of audition appeared to be the middle of the blue and a point a short distance out in the ultra-red. Maximum in the red.

(4.) Some hard-rubber shavings were now placed in the receiver, G. The limits of audibility appeared to be on the one hand the junction of the green and blue, and on the other the outside edge of the red. Maximum in the yellow. Mr. Tainter thought he could hear a little way into the ultra-red, and to his ear the maximum was about the junction of the red and orange.

(5.) A test-tube containing the vapour of sulphuric ether was then substituted for the receiver, G. Commencing at the violet end, the test-tube was gradually moved down the spectrum and out into the ultra-red without audible effect, but when a certain point far out in the ultra-red was reached a distinct musical tone suddenly made its appearance, which disappeared as suddenly on moving the test-tube a very little further on.

(6.) Upon exploring the spectrum with a test-tube containing the vapour of iodine the limits of audibility appeared to be the middle of the red and the junction of the blue and indigo. Maximum in the green.

(7.) A test-tube containing peroxide of nitrogen was substituted for that containing iodine. Distinct sounds

were obtained in all parts of the visible spectrum, but no sounds were observed in the ultra-red.

The maximum effect seemed to me to be in the blue. The sounds were well marked in all parts of the violet, and I even fancied that the audible effect extended a little way into the ultra-violet, but of this I cannot be certain. Upon examining the absorption spectrum of peroxide of nitrogen it was at once observed that the maximum sound was produced in that part of the spectrum where the greatest number of absorption lines made their appearance.

(8.) The spectrum was now explored by a selenium cell, and the audible effects were observed by means of a telephone in the same galvanic circuit with the cell. The maximum effect was produced in the red. The audible effect extended a little way into the ultra-red on the one hand and up as high as the middle of the violet on the other.

Although the experiments so far made can only be considered as preliminary to others of a more refined nature, I think we are warranted in concluding that *the nature of the rays that produce sonorous effects in different substances depends upon the nature of the substances that are exposed to the beam, and that the sounds are in every case due to those rays of the spectrum that are absorbed by the body.*

The Spectrophone.

Our experiments upon the range of audibility of different substances in the spectrum have led us to the construction of a new instrument for use in spectrum analysis, which was described and exhibited to the Philosophical Society of Washington last Saturday.* The eye-piece of a spectroscope is removed, and sensitive substances are placed in the focal point of the instrument behind an opaque diaphragm containing a slit. These substances are put in communication with the ear by means of a hearing-tube, and thus the instrument is converted into a veritable "spectrophone," like that shown in fig. 13.

Suppose we smoke the interior of our spectrophonic receiver, and fill the cavity with peroxide of nitrogen gas. We have then a combination that gives us good sounds in all parts of the spectrum (visible and invisible) except the ultra-violet. Now, pass a rapidly-interrupted beam of light through some substance whose absorption spectrum is to be investigated, and bands of sound and silence are observed upon exploring the spectrum, the silent positions corresponding to the absorption bands. Of course, the ear cannot for one moment compete with the eye in the examination of the visible part of the spectrum; but in the invisible part beyond the red, where the eye is useless, the ear is invaluable. In working in this region of the spectrum lamp-black alone may be used in the spectrophonic receiver. Indeed, the sounds produced by this substance in the ultra-red are so well marked as to constitute our instrument a most reliable and convenient substitute for the thermo-pile. A few experiments that have been made may be interesting.

(1.) The interrupted beam was filtered through a saturated solution of alum.

Result: The range of audibility in the ultra-red was slightly reduced by the absorption of a narrow band of the rays of lowest refrangibility. The sounds in the visible part of the spectrum seemed to be unaffected.

(2.) A thin sheet of hard rubber was interposed in the path of the beam.

Result: Well-marked sounds in every part of the ultra-red. No sounds in the visible part of the spectrum, excepting the extreme half of the red.

* *Proc. of Phil. Soc. of Washington*, April 16, 1881.

These experiments reveal the cause of the curious fact alluded to in my paper read before the American Association last August—that sounds were heard from selenium when the beam was filtered through both hard rubber and alum at the same time. (See table of results in fig. 14.)

(3.) A solution of ammonia-sulphate of copper was tried.

Result: When placed in the path of the beam the spectrum disappeared, with the exception of the blue and violet end. To the eye the spectrum was thus reduced to a single broad band of blue-violet light. To the ear, however, the spectrum revealed itself as two bands of sound with a broad space of silence between. The invisible rays transmitted constituted a narrow band just outside the red.

I think I have said enough to convince you of the value of this new method of examination, but I do not wish you to understand that we look upon our results as by any means complete. It is often more interesting to observe the first totterings of a child than to watch the firm tread of a full-grown man, and I feel that *our* first footsteps in this new field of science may have more of interest to you than the fuller results of mature research. This must be my excuse for having dwelt so long upon the details of incomplete experiments.

I recognise the fact that the spectrophone must ever remain a mere adjunct to the spectroscope, but I anticipate that it has a wide and independent field of usefulness in the investigation of absorption spectra in the ultra-red.

TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

XXXIII.

TELEPHONES.

SINCE the adoption of the Gower-Bell telephone by the Postal authorities a large number have been brought into use. As the conditions under which they have to work differ to a considerable extent, two patterns have been adopted, viz., one with a bell fitted in the instrument itself, and worked by the direct line current; the other pattern is fitted with a soft iron relay, which works a local bell.

The general construction of the instrument is similar to that shown in the number of the Journal for February 1st, page 54; the microphone is formed with eight radiating carbon rods.

Fig. 134 shows the internal connections of the instrument provided with a bell worked by the direct line current.

When the ear tubes are placed in the switches, s_1, s_2, the latter are depressed. A current received from the distant station in this case passes to terminal L, thence through the lever of the button key, K, to the back stop, 2; from the latter it passes through the metal lever, s_1, to the stop, *a*, and from thence through the bell, R, to the brass junction piece, *h*, and from thence direct to earth.

If the key, K, is depressed, then the copper pole of the right-hand half of the battery being connected to contact point, I, passes from thence through the lever of K to terminal L, and out to line; the zinc of the left-hand half of the battery being to earth the circuit is thus complete, and the current from the

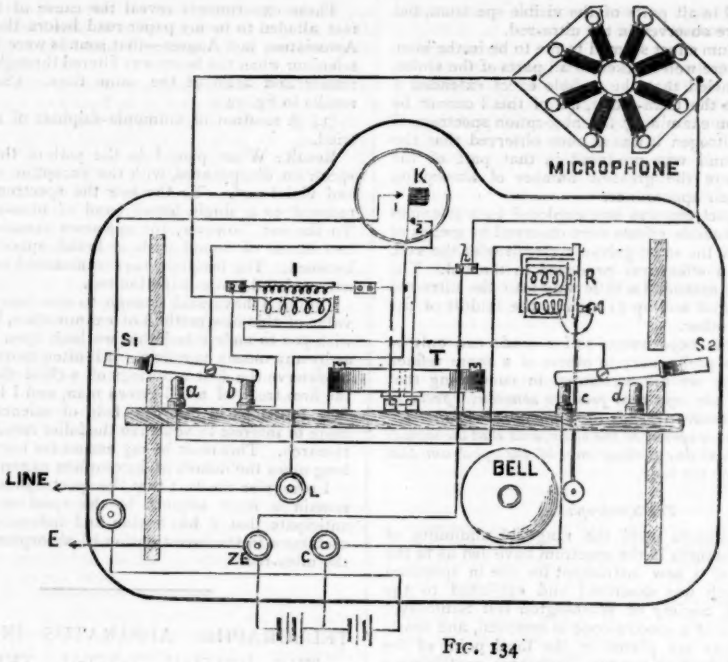


FIG. 134

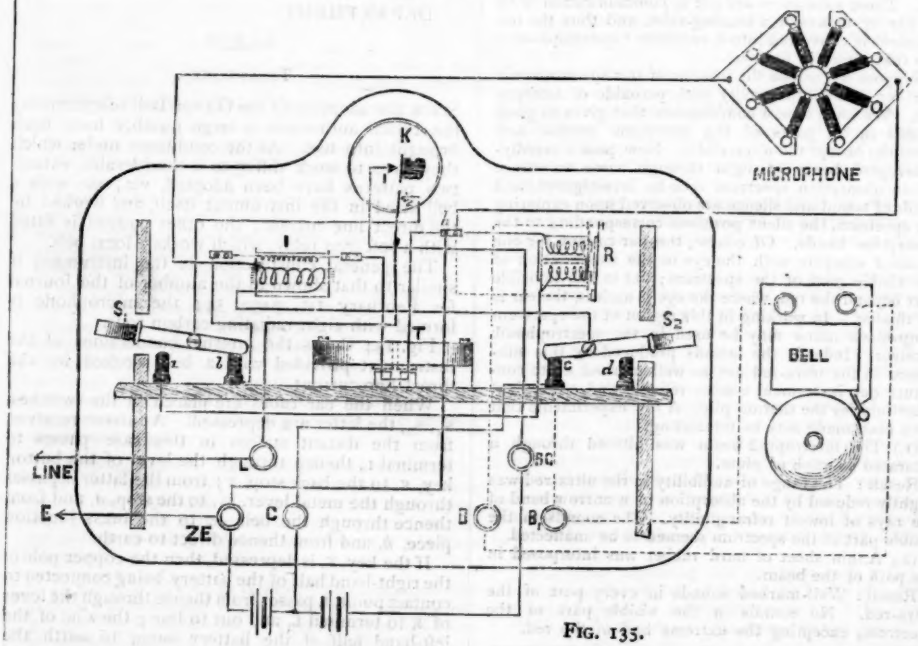


FIG. 135.

whole battery passes out to line and rings the bell at the distant station.

When the ear tubes are taken off the switches, s_1, s_2, then the latter come to the position indicated in the figure. In this case the zinc of the left-hand half of the battery becomes connected through Z, E, *h*, the microphone, the primary wire of the induction coil I, to the switch, s_2, thence to the back contact, *c*, of the latter, and on to terminal C, and the middle of the battery; thus the circuit of the left-hand half of the battery is closed through the microphone and the primary wire of the induction coil. The secondary wire of the latter has one end connected through the back contact, *b*, of the switch, s_1, with contact, 2, of the key, K, and thence by the lever of the latter to terminal L and line; the other end of the induction coil is connected to one end of the telephone receiver, T, whose other end is connected to *h*, and thence to earth.

The arrangement of the circuits in fig. 135 are identical with those in fig. 134, except that the relay takes the place of the bell; and when the tongue of the relay is attracted, the local circuit of the bell is completed with the left-hand portion of the battery by means of the dotted connection shown.

The left-hand half of the battery, which is employed for ringing the local bell and for working with the microphone, need not consist of more than two Leclanché cells for any length of line. The number of cells for the right-hand half of the battery will vary according to the length of the line.

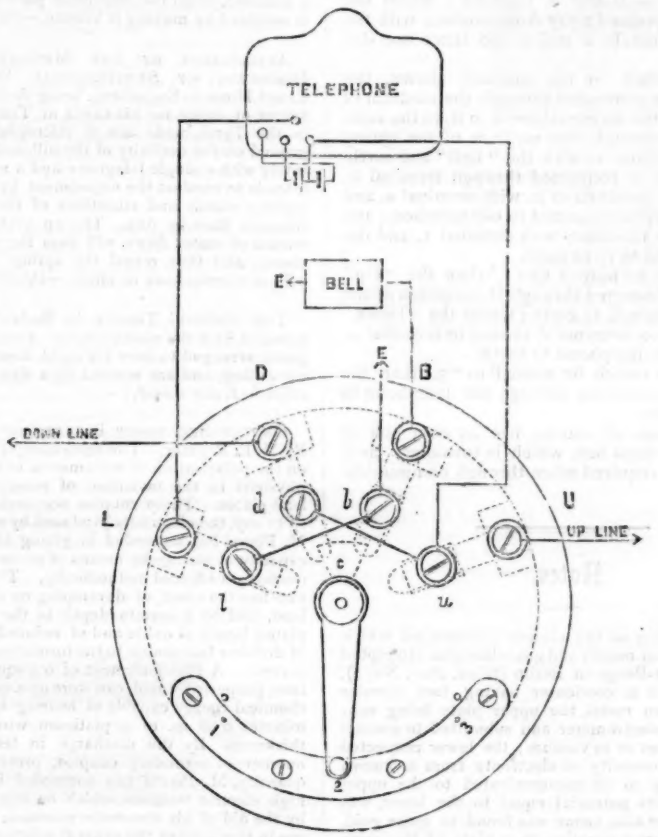


FIG. 136.

The batteries used are the large-sized agglomerate Leclanché, and are found to work well. Care must be taken, however, not to leave the left-hand half on short circuit for any great length of time by leaving the switch, s_2, permanently up.

In cases where a telephone is placed at an intermediate station, it is sometimes required to be able to cut one or other of the terminal stations off when speaking to the other station, the bell being left in circuit with that station which is cut out, so that should that station make a call the latter may be heard. This arrangement is effected by means

of the switch shown by fig. 136. This switch is provided with four pairs of terminal screws, the two terminals in a pair being normally in connection with one another by means of springs. A cam piece, *c*, fixed to the switch handle, rides over these springs, and presses them away from their contacts, and at the same time connects a pair of these springs together; thus, in the figure, the cam has ridden over and pressed away the springs fixed to D and B, from the contacts of terminals *d* and *b*, and has at the same time connected these two springs—that is, terminals D and B, together; whilst the springs being pressed away from contact with the two inner terminals, *d* and *b*, the latter are disconnected.

With the switch in the position shown, the "Down" line is connected through the medium of terminal D, and the spring attached to it, to the cam, *c*, and thence through the medium of the spring attached to terminal B, with the "Bell" and earth. The "Up" line is connected through terminal U, and the spring attached to it, with terminal *u*, and the right-hand wire connected to the telephone, and thence through the latter with terminal L, and the spring connected to it, to earth.

If the switch be moved to "1," then the "Up" line becomes connected through the medium of the cam, *c*, with the bell, to earth; whilst the "Down" line passes on to terminal *d*, thence to terminal *u*, and through the telephone to earth.

Lastly, if the switch be moved to "3," then the "Up" line is connected through the telephone to the "Down" line.

The telephone, of course, has its own bell in addition to the local bell, which is subsidiary, as it were, and only required when through communication is cut off.

Notes.

A DETERMINATION of the electric phenomena which occur on contact of metals and gases has been attempted by Herr Schulze-Berge in Berlin (*Wied. Ann.* No. 2). He worked with a condenser having two circular plates of a given metal, the upper plate being connected with an electrometer and submitted to contact with various gases or to vacuum; the lower connected to earth. The quantity of electricity from a known source requiring to be communicated to the upper plate to make its potential equal to the lower, was measured. *Inter alia*, ozone was found to make gold, platinum, and brass negative to a plate of the same metal in air. Hydrogen always made platinum strongly positive, while its influence on gold was hardly perceptible, and on brass qualitatively various. Chlorine made platinum negative; ammoniacal gas (from aqueous solution) made brass positive. The amount of difference of potential with as similar a treatment as possible of a given pair of plates was very different in the several observations of a series. Nor could a certain relation be discovered between it and the time of action of the gas. It was greatest with two platinum plates, one in hydrogen (viz., 0·214 D). It gradually decreased to a point generally somewhat short of that at the beginning. As to the cause of this decrease, the author thinks it probable that a gradual neutralisation of the electrical double layer takes place.

A DISTURBING CAUSE IN TELEPHONIC TRANSMISSION.—By M. Gaiffe.—Two rods of equal length having been cut from the same steel, of a quality susceptible of strong polarisation without having been tempered, one of them was magnetised as strongly as possible, and they were then introduced into a telephonic circuit. On striking them both in the same manner it was found that the magnetised rod gave energetic currents, whilst the other was relatively inactive. This fact seems capable of explanation on Ampère's theory. In a vibrating magnet there should be produced currents analogous to the extra currents which arise in a solenoid, when the respective position of the spirals is modified by making it vibrate.—*Comptes Rendus.*

APPLICATION OF THE MICROPHONE FOR THE DISCOVERY OF SUBTERRANEAN WATERCOURSES.—Count Hugo v. Engenberg, being desirous of finding a source of water for his castle at Tratzberg, near Hall, in the Tyrol, made use of microphones, sunk in the ground on the declivity of the hill, and connected separately with a single telephone and a small battery. He intends to conduct the experiment by night, when disturbing sounds and vibrations of the ground are less frequent than by day. The apparatus, near which a stream of water flows, will pass the sound to the telephone, and thus reveal the spring. Stagnant water will, of course, have no effect.—*Oesterr.-Ungar. Post.*

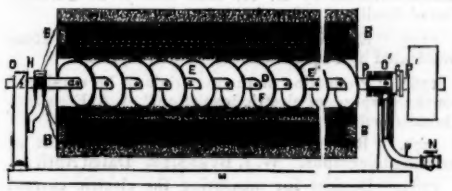
THE National Theatre in Buda-Pest is now illuminated with the electric light. Five lamps of ground glass, arranged to burn for eight hours, are fixed near the ceiling, and are worked by a dynamo-electric machine.—*Pester Lloyd.*

ON THE SECONDARY BATTERY OF M. C. FAURE.—By M. E. Reynier.—The researches of M. Gaston Planté on the polarisation of voltameters have led this learned physicist to the invention of secondary couples with lead plates. These couples accumulate and store up, so to say, the electricity produced by any electro-motor. M. Planté has succeeded in giving his couples a great capacity of storage by means of successive charges and discharges effected methodically. This work of *formation* has the effect of developing on the surface of the lead, and to a certain depth in the thickness of the plates, layers of oxide and of reduced metal in a state of division favourable to the formation of the secondary current. A Planté element of 0·5 square metre of surface, properly formed, can store up a quantity of electrochemical energy capable of heating to redness for ten minutes 0·08 m. of a platinum wire of 0·001 m. in thickness. By the discharge in tension of a great number of secondary couples, previously charged in quantity, M. Planté has succeeded in obtaining very high electric tensions, which he has further increased by the aid of his rheostatic machine. Some engineers see in this battery the general solution of the question as to the transportation and distribution of electricity, and consequently of energy in all its forms—mechanical force, heat, light, chemical action, &c. But in order to obtain these results it was necessary to give the apparatus a greater capacity of storage, along with a less weight and bulk. This has in fact been effected by M. Faure, whose improvements render the industrial accumulation of electricity possible. The secondary battery of M. Faure is a modification of the Planté battery. The electrodes are of lead, plunged in water acidified with sulphuric acid, but its formation is more thorough and more rapid. In Planté's battery the formation is limited by the thickness of the lead plates. M. Faure gives his couples rapidly an almost boundless power of accumulation by coating the electrodes with

a layer of spongy lead, formed and kept in its place in the following manner:—The two lead plates of the element are each covered with red lead, or another insoluble oxide of lead, and are then surrounded with a felt partition, kept in its place with rivets of lead; these two electrodes are then placed near to each other in a recipient containing acidulated water. If they are very long they are rolled in a spiral. The couple being thus fitted up requires merely to be traversed by an electric current, which brings the red lead to the state of peroxide upon the positive electrode, and to the state of reduced lead on the negative electrode. As soon as the whole mass has been electrolysed the element is formed and charged. On discharging the reduced lead is oxidised, and the peroxidised lead is reduced until the element becomes inert, and is ready to receive a new charge of electricity. Practically a Faure battery of 75 kilos. can thus store up a quantity of electricity capable of doing the work of one horse-power for an hour. Calculations based upon thermo-chemical data show that the weight of the apparatus may be much reduced. The yield of the Faure battery may in certain conditions reach 80 per cent. of the work expended in charging it.—*Comptes Rendus.*

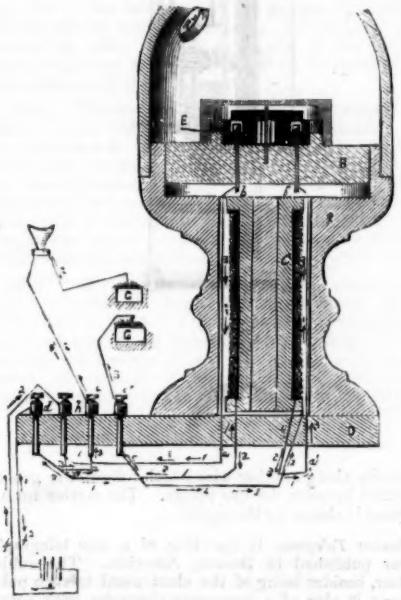
A LARGE meeting of telegraph clerks was held recently at Newcastle-on-Tyne. Severe disappointment was expressed at the continued absence of any notification from the authorities as to whether steps are being taken to remove their grievances. The following resolution was unanimously adopted:—"That, in the opinion of this meeting, there is ground for grave anxiety on the part of the telegraph staff owing to the prolonged delay in the announcement of any scheme of revision for their department, and the absence of any official intimation that the grievances of which they have so long complained are recognised, and that redress is contemplated."

VOELKER'S DYNAMO-ELECTRIC MACHINE.—The armature-cores of this machine, which is shown by the figure, are composed of wires held in slots in a cylindrical carrier, the ends of the wires being bent down upon the wires of the bobbin and the inside of the carrier. Water is conveyed through the hollow shaft and distributed, by means of small holes in the shaft, upon absorbent material, which lines the inner portion of the



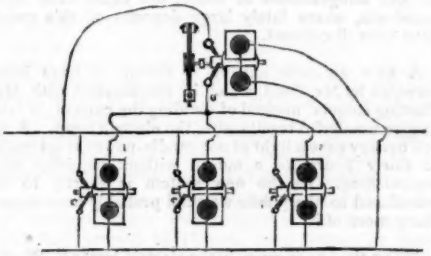
armature. An Archimedean screw within the armature creates a draught of air through the machine in contact with the wet absorbent material. The various parts of the machine are as follows:—The iron wire field magnets, I I, armature bobbin cores, A A, iron cylinder, C, absorbing lining, F, screw, D, hollow shaft, E, commutator, H, brushes, *h h'*, bobbins, K K, bearings, O O', water pipe, P, valve, N, packing boxes, *p p'*, and pulley, S.

LOCKWOOD'S TELEPHONE TRANSMITTER. — This transmitter, shown by the figure, consists of a fixed metal cylinder or base supporting the microphone and inclosing the coil. A dome or mouth-piece, made in the form of a hollow hemisphere, forms a cover for the transmitter; this dome or mouth-piece is made adjustable or susceptible of being rotated on its base or support. A fixed cylindrical metal stand supports the microphone and incloses the coil. The fixed hollow metal stand or base supporting the microphone and inclosing the coil, in combination with a wire or conductor



connecting said fixed base with the ground, substantially as and for the purpose described. The microphone itself consists of a disc of carbon lying on two supporting pieces of the same material.

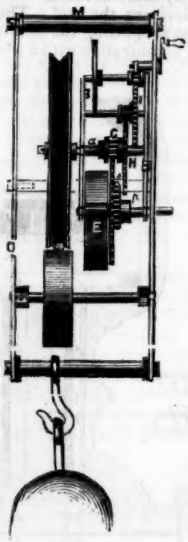
MR. EDISON has recently patented a new method of regulating the generation of electric currents; in this arrangement, which is indicated by the figure, he employs the reverse current from an electric engine to intensify



the field magnets of the generators. The engine is driven by the current from the generators, and its speed varies with the strength of the current.

A NOVEL method of laying telegraph wires has been patented in America by Mr. E. T. Greenfield. This method consists in carrying the ends of the wire from

one point of attachment to another by means of a carrier, driven by a main-spring, which moves auto-



matically along another wire which follows the general direction between the two points. The carrier for the purpose is shown by the figure.

Boston Telegram is the title of a new telegraphic paper published in Boston, America. The subject matter, besides being of the class usual to such publications, is also of a humorous character, with corresponding illustrations well executed.

ONE of the automatic machines which prints the news on tapes of paper at the clubs is said to have delivered a portion of its message on the Opium Bill thus:—"8.30, Mr. Pease still drugging the House." It should have been "addressing."

NICKEL.—The French official returns of the importation of nickel into France during 1879, show that 561,568 kilogrammes of nickel ore came from New Caledonia, where lately large deposits of this metal have been discovered.

A NEW galvanic battery is stated to have been invented by Mr. Coad, which in combination with Mr. Banting Rogers' method of dividing the current, is said to give wonderful results with the electric lamp. A 20 cell battery gave a light of 200 candle-power at intervals of thirty hours for a month without requiring any replenishing. As the new system is shortly to be introduced to the public we shall probably hear something more of it.

MORE than once recently the electric lamps on Blackfriars Bridge, in Bridge Street, at Ludgate Circus, in St. Paul's Churchyard, and along a portion of Cheapside—the lamps supplied on the Brush system—were suddenly extinguished. As there have been very few gas lamps in the streets lighted, the extinction of the electric light placed those thoroughfares in total darkness, to the great inconvenience of passengers and drivers of cabs and omnibuses. The cause of the failure was defective insulation of the wires; the latter are being renewed by ones of stronger make, which will obviate any future failure.

IT is proposed to light the Melbourne Houses of Parliament by the electric light.

New Patents—1881.

1636. "Improvements in apparatus for producing motion by electricity, specially applicable to regulating the electromotive force in systems of applying or distributing energy by electricity for lighting or other purposes." St. G. L. FOX. Dated April 14.

1653. "Electric lamps." J. H. JOHNSON. (Communicated by the Société la Force et la Lumière, Société Générale d'Electricité.) Dated April 14.

1670. "Electric lamps." G. S. GRIMSTON. Dated April 16.

1676. "Secondary electric or galvanic batteries." J. H. JOHNSON. (Communicated by C. A. Faure.) Dated April 16.

1679. "Improvements in telephonic and telegraphic exchange systems, and in insulating and mounting the conducting wires used for telephonic and telegraphic communication." J. N. CULBERTSON and J. W. BROWN. Dated April 16.

1683. "Electrical apparatus for signalling between railway trains in motion and between trains and stations." A. M. CLARK. (Communicated by A. D'AURIAC.) Dated April 16.

1685. "Electric lamps or regulators." A. M. CLARK. (Communicated by J. M. A. Gerard-Lescuyer.) Dated April 18.

1696. "Telegraphy." S. PITT. (Communicated by O. Lugo.) Dated April 19.

1699. "A new or improved method of block signalling for railways." J. WETTER. (Communicated by R. S. Jennings.) Dated April 19.

1726. "Electrical call or signal apparatus for telegraphic or telephonic purposes." W. R. LAKE. (Communicated by D. H. Rice and J. B. Currier.) Dated April 20. (*Complete.*)

1745. "Electrical batteries." C. D. ABEL. (Communicated by P. Jablochkoff.) Dated April 22.

1762. "Production of the materials to be employed for the purposes of electric insulation." J. A. FLEMING. Dated April 23.

1770. "Receiving and transmitting apparatus of printing telegraphs." W. J. BURNSIDE. Dated April 23.

1783. "Devices for measuring the electric current passing through or used upon a certain circuit." E. G. BREWER. (Communicated by T. A. Edison.) Dated April 25.

1787. "Dynamo-electric machines." A. M. CLARK. (Communicated by H. J. Müller and A. Levett.) Dated April 25.

1789. "Improvements in block signalling on railways and in apparatus connected therewith." J. W. FLETCHER. Dated April 26.

1796. "Railway signalling." H. MORRIS. Dated April 26.

1802. "Improvements in electric lights and fittings and fixtures therefor." P. JENSEN. (Communicated by T. A. Edison.) Dated April 26.

1809. "Telegraphic cables or conductors." W. R. LAKE. (Communicated by P. B. Delany.) Dated April 26.

1826. "Galvanic soles for shoes and boots, chiefly applicable as socks for same." G. W. Von NAWROCKI. (Communicated by A. Wienand.) Dated April 27.

1835. "Current governors for dynamo-electric machines." H. J. HADDAN. (Communicated by C. F. Brush.) Dated April 28.

1852. "Improvements in electric lighting and in apparatus therefor." H. J. HADDAN. (Communicated by L. Somzée.) Dated April 29.

1856. "Improvements in the construction of railways, and in the adaptation thereto of telegraph wires." A. W. L. REDDIE. (Communicated by J. Hunebelle.) Dated April 29.

1873. "Telegraph cables and other electrical conductors." W. T. HENLEY. Dated April 30.

1885. "Electric telephones." W. MAIN. Dated May 2.

1905. "Electro-telegraphic apparatus." J. H. THOMSON. Dated May 3.

1918. "Manufacture of carbon conductors for incandescent electric lamps." E. G. BREWER. (Communicated by T. A. Edison.) Dated May 3.

1922. "Improved construction or arrangement of electric lamp." J. B. ROGERS. Dated May 3.

1929. "Improvements in apparatus for alarm signals in railway trains." COMTE (PIERRE AMBJÖRN) DE SPARRE.

1942. "Electric arc lamps." J. BROCKIE. Dated May 4.

1943. "System of electric lighting." E. G. BREWER. (Communicated by T. A. Edison.) Dated May 4.

1950. "Electro-telephonic, or telephonic apparatus." W. R. LAKE. (Communicated by L. Maiche.) Dated May 4.

1953. "An apparatus for controlling the lowest height of water-level and the maximum temperature in steam boilers by the medium of electricity." C. PIEPER. (Communicated by R. S. Kopff.) Dated May 5.

1961. "Improvements in magneto-electric machines, in their circuits, and in the method of operating them." P. HIGGS. Dated May 5. (*Complete.*)

1968. "Electric lighting apparatus." W. R. LAKE. (Communicated by N. Bouliguine.) Dated May 5.

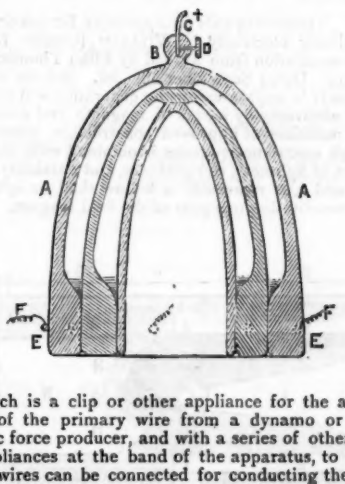
ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1880.

2459. "Railway signalling." ALPHONSE AUGUSTE DUPONT. (A communication from abroad by Joseph Bachrich, of Paris.) Dated June 17. 8d. The march of every train is automatically marked so that the chief of the neighbouring stations may see the exact state of the way, calculate the speed of the trains, and in case of probable danger give the necessary instructions for slackening the march or stopping. Signals of divers sorts are transmitted by said chief of station, which are instantaneously perceived by all the trains on all the extent of the way; the machinists can stop their locomotive and prevent all collision. Other signals enable the machinists to advise that the orders received have been well understood and punctually executed. Finally, on the other hand, it is possible for any train in distress to call for the assistance it may be in need of, which succour can be sent to the very spot where it is, said spot being always very exactly pointed out.

3438. "Securing telegraph wires to their insulators." ARTHUR EDWARD GILBERT. Dated August 25. 2d. Has reference to the gripper described in the number of the TELEGRAPHIC JOURNAL for September 15, 1880. *(Void by reason of the patentee having neglected to file a specification in pursuance of the conditions of the letters patent.)*

3784. "Electric type printing telegraph apparatus." GEORG JONAS DROSTE. Dated September 18. 10d. Has reference to type printing telegraphs in which, by continuous contact closings and interruptions of the line current passing through the electro-magnets of the instruments in connection, the type disc is moved round from letter to letter until the type of the letter to be telegraphed stands opposite the printing appliance which when put into action prints it on a paper band.

3809. "Dividing and subdividing the electric current for lighting." JOHN BANTING ROGERS. Dated September 20. 6d. The object of this invention is improved means and apparatus for dividing and subdividing the electric current for lighting purposes, by means of conical, semispherical, or bell-shaped apparatus of copper (shown by the figure), to the apex



of which is a clip or other appliance for the attachment of the primary wire from a dynamo or other electric force producer, and with a series of other clips or appliances at the band of the apparatus, to which other wires can be connected for conducting the fluid to any desired number of lamps or carbons. The apex of the apparatus is flat or nearly so, and of greater thickness than the body, that the fluid may be accumulated and governed in and by the apparatus.

3880. "Systems of conductors for the distribution of electricity, &c." PETER JENSEN. (A communication from abroad by Thomas Alva Edison, of Menlo Park, America.) Dated September 24. 6d. Where many translating devices converting electricity into either power or light are arranged upon the multiple arc or derived circuit system, it is essential that so far as possible an equal electromotive force or "pressure" be maintained in all parts of the system. When however each set of conductors are run out from the central station in a straight circuit containing a number of translating devices, the pressure, when a number of

devices are in operation, is apt to be greatest nearest the central station, and to diminish gradually towards the end of the conductors, this "drop" being due to the resistance of the main conductors. The object of

this invention is to obviate such irregularity, and to maintain practically throughout the entire system an equal pressure. This is accomplished by using the conductors leading directly from the source of energy as feeding conductors only, placing no lamps ordinarily in the circuit connected directly to the source, placing the lamps or translating devices upon service or lamp circuits which connect to, and are fed by, the feeding conductors, in such manner that all the lamp circuits are electrically distant substantially from the source of electricity by the same mass of conductor. By so doing the greater portion, if not all, the drop occurs in the feeding conductors, the pressure in the service or lamp circuits being practically uniform at all points. The figure shows one method of carrying out the arrangement. (In this figure the main conductors, although shown of uniform thickness, in reality are made larger at their home ends, gradually tapering at the outer end of the system.)

3928. "Improvements in apparatus for generating and utilising electricity." WILLIAM ROBERT LAKE. (A communication from abroad by Elihu Thomson, of America.) Dated September 28. 8d. Relates to improvements in apparatus for the generation and utilisation of electricity by means of magneto and dynamo-electric machines of improved construction, whereby a very high electromotive force is obtained with the advantages of lightness, compactness, and durability. In figs. 1 and 2, N represents a hollow shell or cylinder of iron constituting one pole of the field magnet. The

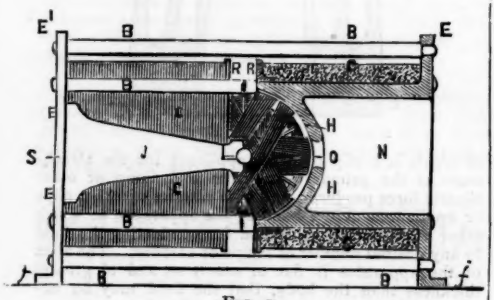


FIG. 1.

outer edge, F, of this cylinder is flanged, and its inner face, H, is shaped to conform to the circular outline of the armature of the machine as shown. If desired, a solid cylinder may be used instead of a hollow one. An opening (or openings) through the face, H, is provided, as at O, to allow the circulation of air through the centre of the shell, N. A similar shell of iron, S, is placed opposite to the said shell, N, and is also flanged, as shown at F^1; this shell, S, constitutes the opposites pole of the field magnet. In the figure the shell, S, is shown covered by its coil, c^1, c^1. Bars or pieces of iron, B, B, serve to connect the flanges, F, F^1, and are preferably let into holes in the latter; these bars are of sufficient number and size to make thorough magnetic contact between the aforesaid flanges, F, F^1. The coils of insulated wire, C, C, and c^1, c^1, surround the field magnet poles, N and S, and also the armature of the machine, and serve for the direct magnetisation of the said poles, and of the armature itself. Rings, R, R, of metal or other suitable material, may be provided to keep the coils, C, C, and c^1, c^1, in place, since in most cases the latter project beyond the poles, N and S, and over the armature. If desired, the two coils, C, C, c^1, c^1, may be combined to form a single coil. The electric current traversing the coils, C and c^1, for magnetisation, travels in the same direction in both coils, and may be derived either from the machine itself, or from any other suitable source; the opposing faces of the poles, N and S, are thereby magnetised with opposite polarities. The bars, B, are situated near the outside of the coils, C, c^1, and are therefore magnetised by the said

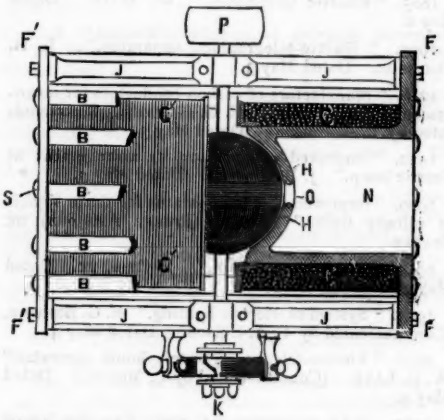


FIG. 2.

coils, the direction of their magnetisation being such as to intensify the magnetisation of the poles, N and S. The opposing faces, H, H, of the said magnets, N and S, between which faces the armature revolves, form, as shown, portions of a hollow sphere, the armature itself when wound with wire being spherical in outline. J represents a portion of the arm supporting the journals of the shaft of the armature, and *f*, f^1, are the feet of the machine. The armature employed in the present invention is spherical in form, as above stated, this form being found to possess great advantages.

Correspondence.

DESTRUCTION BY LIGHTNING.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—The accident which occurred on the 26th ult., at the Board School in Orange Street, Southwark, is another proof to me how little care is taken, even by such institutions (otherwise so well managed) as the

London School Board, to protect life and property against the destructive influences of the fiery flashes from the clouds. It is more than a century since Benjamin Franklin showed us the simple method of protection against lightning, and it may seem almost incredible that hundreds of buildings are still annually destroyed, and hundreds of lives lost by these discharges of electricity. I have just received an official letter from the Minister of Agriculture, Industry, and Commerce, of Italy, informing me that during the 16 years from 1864 to 1879 no fewer than 1,906 lives were lost in that country through fatal accidents from lightning. I beg to append a list of these casualties, as I received them from Rome. Can meteorological influences be traced to the astounding preponderance of accidents in certain years, such as 1868 and 1873?

I am, &c.,

RICHARD ANDERSON.

Rose Cottage, New Malden,
Surrey.
2nd May, 1881.

Deaths caused by lightning in Italy in the years 1864—1879:—

Years.	Deaths per Year.	Males.	Females.
1864	91	72	19
1865	76	54	22
1866	54	43	11
1867	98	62	36
1868	237	186	51
1869	109	79	30
1870	110	75	35
1871	99	76	23
1872	134	101	33
1873	184	136	48
1874	167	128	39
1875	137	96	41
1876	147	114	33
1877	92	66	26
1878	100	82	18
1879	71	52	19
Total	1,906	1,422	484

NAPIER'S SPEED MEASURER.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—In answer to Mr. Moritz Kohn's letter, desiring information respecting Napier's speed measurer, which was used by Mr. Schwendler in his experiments, I may say that although the instrument satisfied all the purposes required, and was indeed invaluable in showing the exact speed at sight to the slightest variation, it was not in the form quite suited for the market, nor did it embody some important improvements which Mr. Napier has since been working out. As soon as the final forms of this instrument, for the various purposes to which it is applicable, are arranged, I shall be able to furnish you with a full description and explanatory drawings.

Yours faithfully,

SHOWSPEED.

THE COLOUR OF THE ELECTRIC LIGHT.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—Your correspondent "Electron" remarks on the colour of the electric lights now at work in the City. Having given special attention to this subject, I hope you will allow me to trespass on your valuable space with a few remarks. First, as regards the Brockie system, to which he justly says "the highest encomium is paid," I consider, with all due allowance for the excellence of the Gramme machine, that the success is mainly due to the carbons, which are a special make of the Electric Carbon Company of London. Having noticed the unpleasant effect of the blue light in the electric arc, I experimented for some time as to the best way of improving the light, and I found this could be done in three ways: first, by incorporating lime or magnesia with the carbons at the time of combustion. This partly takes place in the Jablochkoff candle, but with better result in a lamp of mine in which the electric arc is caused to impinge on a block of lime and produce a perfectly steady light. The second plan is by introducing such substances into the carbon, which, without interfering with the resistance, should tone the light and nullify the effect of the violet rays; this plan is carried out at Cannon Street Station. The third method is by colouring the glass globes with a suitable pigment, which should so colour the light that it almost resembles that from a powerful gas burner. Numerous experiments with coloured globes have been carried out with the view of lighting the picture galleries at South Kensington, for which purpose the electric light has hitherto not been found suitable. With suitably coloured globes I should have no hesitation in lighting the interior of any theatre, and besides a considerable saving of cost, could do away with that dangerous and unsightly gas furnace—the sun burner. Curiously enough the carbons used in the four systems noticed by your correspondent are each made in different countries. The Jablochkoff candle comes from France, the Siemens from Germany, the Brush from America, and lastly those used with the Gramme are of home production, the quality of which we have no reason to be ashamed of.

Your obedient servant,

KILLINGWORTH HEDGES, C.E.

25, Queen Anne's Gate, Westminster.
May 7th, 1881.

HENLEY'S OZOKERIT CABLE CORE.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—It may be of interest to you to know that my company has secured a contract from the Compagnie de Télégraphie Sous-Marine de l'Amérique Centrale for the manufacture and laying of a submarine telegraph cable of about 400 miles, to be laid from Belize (British Honduras) to the island of Cuba. By means of this cable and its tributary land lines all Central America will be telegraphically connected with the United States and Europe. It is now being made at our works, and arrangements have been entered into for its being laid during the ensuing summer.

I may mention that my patent ozokerited core will be used; the insulation of this core is ten times higher than gutta-percha, as proved by Mr. Preece of the General Post-Office, and it is coming largely into use for telephones, torpedo cables, &c., &c.

I am, Sir, yours truly,

(For W. T. HENLEY),
Managing Director,

8, Draper's Gardens, Throgmorton Street, G. S.
April 30th.

P.S.—I inclose a copy of Mr. Preece's report for your perusal.

[COPY.]

GENERAL POST OFFICE,
5th April, 1881.

DEAR SIR.—I have much pleasure in forwarding to you the following results of the tests we have made of the ten miles of ozokerit core which you recently supplied to the department.

Conductor resistance	23·723 ohms.
Capacity	·281 mf.
Insulation	8,196 megohms.
Temperature	75° Fah.

TESTS OF GUTTA-PERCHA CORE OF SIMILAR LENGTHS.

Conductor resistance	22·36
Capacity	·273 mf.
Insulation	860 megohms.
Temperature	75° Fah.

It will be seen from the above that the quality of your core compares very favourably with that of gutta-percha. It appears to deserve a trial as the core of a submarine cable.

I am,
Yours very truly,
(Signed) W. H. PREECE.

W. T. Henley, Esq.

Proceedings of Societies.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

AN ordinary general meeting of this Society was held on Thursday, April 28th, Mr. LATIMER CLARK, vice-president, in the chair. The minutes of the last general meeting having been read and confirmed, and the list of new and proposed members read, the postponed discussion on Mr. St. George Lane Fox's paper on "The application of electricity to lighting and heating for domestic and other purposes" was opened.

Mr. SHOOLBRED said that it seemed to be overlooked in discussing Mr. Fox's paper, that arc as well as incandescence lights would have to be considered in dealing with the problem of general electric lighting. The incandescence lights possessed the great advantage of not requiring regulation like the arc lights. He thought that there would be considerable difficulty in getting the lamps of equal resistance. He would ask whether the earth was used as a return circuit. The meaning of subdivision he considered had been not clearly understood. Putting a number of lights in one circuit was not subdivision. There could be no doubt that the loss of light resulting from employing a number of lights as against a small number had been very much exaggerated, and was very much less than was at first stated; the actual loss was very slight.

Captain SALE, R.E., thought that the estimate of 160 candle-power per horse-power, per 1¾ lb. of coal, was not at all a fair estimate. In the case of gas, the price put upon it represented so many cubic feet delivered at the burners; in fact, the cost of the coal in electric lighting was by no means the only expense.

Mr. ALEXANDER SIEMENS contended that competition in electric lighting, as in everything else, was a great thing; he thought Mr. Fox deprecated this. With regard to Mr. Fox's theory to explain the action of electricity, he could not see the use of employing it in the place of the ordinary theory, which was quite correct and comprehensible. He could not agree with Mr. Fox that incandescence lighting was the only one suitable for the purpose stated; he would undertake to light with arc lights if he were asked to do so. The earth, he might mention, was often employed as a return circuit, but it was very essential that it should be thoroughly good. Opinions as regards subdivision had decidedly changed. The question of storing up energy had often been spoken of; this was effected in reality if the engine fires were banked up, as the energy then remained stored in the coal.

Mr. DONOVAN asked in what respect Mr. Fox's lamp differed from Swan's; the two seemed almost exactly alike.

Mr. C. F. VARLEY said that the views which had been expressed as to electricity being like a compressible fluid were quite incorrect. Faraday had thoroughly examined the question, and had come to the conclusion that electricity was quite incompressible. Electricity was a vehicle of force, not a form of latent energy. The calculations as to the resistance of the lamps he did not consider correct; the resistance was 45 per cent. less when hot than when cold.

Mr. R. E. CROMPTON said that the incandescence lamps could be made to any resistance required. As regards the cost of engine power, he would point out that one engine would not do the work required, and several small engines cost proportionately more than one large one. He did not think that the consumption of coal could be estimated at less than 2½ lbs. per horse-power per hour.

Professor PERRY pointed out that light was not energy only. This the equation to the force showed.

Mr. HEINRICHS said that although Mr. Fox's lamps were in many respects the same as those of Swan and Edison, yet the fact that there were certain small points of difference entitled them to be considered as improvements, as in any other invention.

Mr. BETTS considered that great confusion existed in the definitions of the terms "series," "multiple," "arc," &c. He thought it highly advisable that the terms should be more clearly defined.

After a few remarks by Professor AYRTON, Mr. LANE FOX rose to reply:—With reference to the exact cost of lighting a house by his system, it was impossible to give a definite answer, as so much depended upon details. While paying a great tribute to Mr. Edison for his work, which he considered had been chiefly beneficial by the excitement it had created, he would point out that his own patents were prior to those of Edison. The arranging of lamps in quantity or in series really depended entirely upon the arrangement of the wires and the resistance, &c., of the dynamo machines, both systems could be made to answer equally well if necessary. His paper was more particularly read for the purpose of eliciting a discussion and not for bringing forward a perfect system of electric lighting. The practicability of coupling up dynamo machines in multiple arc had been doubted, but he believed Mr. Edison had practically done this. If engines of 1000 horse-power were employed, they could certainly be worked with an expenditure of 1½lb. of coal per horse-power per hour. He thought that the electric light would open up a great field for unemployed labour. Arc lights, he considered, would disappear altogether in time, as the cost of the carbon electrodes was a serious item of expense. Captain Sale's remarks he did not agree with. He quite thought, with Mr. Betts, that the definitions of the terms he referred to might be put clear with advantage. In reply to a question with reference to the electric regulator, he would state that the idea was purely diagrammatic, and required to be practically worked out.

The meeting then adjourned.

City Notes.

Old Broad Street, May 11th, 1881.

INDO-EUROPEAN TELEGRAPH COMPANY.—The fourteenth ordinary general meeting of the shareholders of this Company was held on April 28th, at the New Exchange-buildings, George-yard, Lombard-street, Colonel J. Holland in the chair. The chairman moved the adoption of the report, a resolution which was seconded by Mr. D. Barlow. The chairman said that, before putting the resolution to the meeting, he would like to make a few observations. When affairs were reasonably prosperous reports were short, and in proportion the main facts were contracted in a few words. They had earned £12,000 more gross profits than they did in the preceding year, while their outlay had only been about £600 additional. He thought the proprietors would admit that that was a very satisfactory result. The details of the expenditure were set forth in the revenue account, and any further information he would be happy to give. Sundry creditors and sundry debtors were the two largest figures, the former amounting to £12,975, and the latter to £30,896. The whole of those, however, had run off. They were running accounts which were kept on both sides. They had to pay certain sums to various companies and constituents, and they had to receive various sums in a like manner. On examining the list of unsettled accounts for the last month they found only one item, and that was £700 due from the Secretary of State for India, and therefore they were pretty well posted up; and, so far as they knew and so far as Mr. Andrews knew, there was not a single bad debt. Before recommending a dividend, the directors had determined to lay aside a certain sum. Thus they had set aside £7,500 to reserve, which he thought the shareholders would agree was a substantial figure. Their relations with their customers and with other companies with whom they had business transactions, continued to be cordial, and there was every reason to hope that they would continue so. The report also referred to the appointment of Mr. Andrews as managing director (hear, hear). He was glad to hear that expression of approval, although he never doubted for a moment that the shareholders would be gratified by the announcement. Mr. Andrews' duties remained the same as before, and the appointment was really a complimentary notice of his exertions. The change, however, placed him in a better position with regard to other companies and the Governments associated with them. The board had felt that anything they could do to raise or improve Mr. Andrews' position was not only a pleasure but a duty, and they also felt it their duty to communicate with the Governments of Germany and Russia the fact that Mr. Andrews had been appointed managing director, and from the representatives of those Governments replies had been received which he desired to read, because Mr. Andrews had been obliged to be in constant communication with them. The present German Minister of Posts and Telegraphs, his Excellency Dr. Stephan, wrote as follows:—"I have been informed that the board of the Indo-European Telegraph Company have appointed you managing director. Permit me to express to you my congratulations upon this event. Since I had the pleasure of making your personal acquaintance at St. Petersburg in 1875, the judicious and intelligent conferences then engaged with you upon administrative and tariff questions embraced in the subject of telegraphy have always been a pleasant remembrance to me. I am convinced that the choice of the board could not have fallen upon a more competent and worthy gentleman, and I congratulate the Company on their having you at their head as managing director. Accept the expression of my particularly high esteem." On the same subject, his Excellency General von Lüeders, the Director-General of the Imperial Russian Telegraphs, wrote:—"I have received your communication of the 31st of March, sub No. 2686, and I am much pleased that your services in the skilful management of the Company's business, and in the maintenance of the Company's interests, have been acknowledged by your appointment to the managing directorship. At the same time I beg to send you my sincere congratulation upon this promotion, and hope that the good relations hitherto existing with my Government will continue unaltered. I take this opportunity to assure you of my continued high esteem." Mr. Grimstone expressed satisfaction at the past position of the Company, and the prospects held out for the future. He was also pleased to find that the board had acted upon a sound principle in building up a reserve and laying the foundation for the prosperity of the Company. The consequence of this had been that each half year their property had become more valuable. The chairman said that the policy which Mr. Grimstone approved of was the policy which that gentleman inaugurated when he was at the board. Although there was no particular reason for supposing that the result of the present year might not be so good as that of the past, still it might not be so, as they had done a great deal of business with the Government, owing to the Candahar question. In view of such possible fluctuations, it was thought desirable to keep the dividend at its present figure, and divide anything beyond in the shape of a bonus. The resolution for the adoption of the report was carried unanimously, and the dividend therein recommended was declared. The directors having been authorised to contribute to the servants' assurance endowment and pension fund, in accordance with the intimation contained in the report, the retiring directors, Messrs. W. H. Barlow, A. Delbruck, and J. B. Gossler, and the retiring auditors, Messrs. Kemp, Ford, & Co., were unanimously re-elected, and the meeting closed with a vote of thanks to the chairman and directors.

SUBMARINE CABLES TRUST.—The tenth annual ordinary meeting of the certificate holders in this trust took place on May 3rd, at No. 66, Old Broad-street. Mr. J. Pender, M.P., presided. The accounts for the financial year submitted showed that the revenue for the twelve months, including the balance brought from last year's accounts, viz., £2,539 11s. 7d., and the dividend on the Eastern Extension Shares (£1,696) referred to in the last report, amounted to £25,913 9s. 4d. The expenses of the trust, including the sum of £303 18s. 1d. legal charges in excess of the amount already reserved for the purpose, amounted to £1,647 18s. 6d. Payment of two coupons at the usual rate of 6 per cent. per annum had absorbed £20,442, the sum of £3,046 7s. 1d. has been transferred to the "redemption fund," and the balance of £777 3s. carried forward. From the report it appeared that by the trust deed authority was given to the trustees to sell any of the securities held by the trust when they could do so at a profit of 30 per cent. above cost price. During last year the trustees had sold 300 shares in the Eastern Extension Company at a fraction under par, making a profit on the sale of over 40 per cent. The amount realised was invested in the purchase of Submarine Cable Trust Certificates. The chairman, in moving the adoption of the report and statement of

accounts, said they had commenced the year with the very substantial balance of £2,539, which was increased by £1,696, being the dividend on the Eastern Telegraph share which had been earned in the previous year. The law expenses during the year had been higher than in the year before, and they had been temporarily placed in the Court of Chancery. The condition of the certificates had been somewhat affected by the competition, but since the 1st of October this had been recovered, and since which time the Anglo-American had been earning fair dividends. Further competition was projected, and, if not avoided, might, for a time, adversely affect their revenue. In consequence of the illness of Mr. William Newmarch, one of the auditors appointed at the last annual meeting of certificate holders, the accounts presented bore the signature of only one auditor—viz., Mr. J. G. Griffiths. Mr. Newmarch had been seriously ill, and therefore unable to attend to his duties. He was, however, better now, and he trusted that the certificate holders would again elect him to the post of auditor. In reply to a question, the chairman said he did not know of any opposition except from Mr. Jay Gould, who said he wished to rate New York the centre of telegraphy. It had been said that half a dozen companies were likely to crop up, but he only knew of this one. The report was then adopted unanimously. Mr. W. Newmarch and Mr. J. G. Griffiths were then re-elected auditors for the ensuing year, which concluded the business of the meeting. A vote of thanks to the chairman closed the proceedings.

THE board of the Direct United States Cable Company have resolved upon the payment of an interim dividend of 5s. per share, being at the rate of 5 per cent. per annum for the quarter ended March 31st, 1881.

THE WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED.)—The report of the directors to be presented at the eighth ordinary general meeting of members, to be held on 18th May, 1881, contains the accounts for the six months ending 31st December, 1880, and states that the receipts for the half-year amounted to £19,694 11s. 3d. To this is added £5,841 12s. 9d. brought from last half-year's accounts, and £5,372 4s. 11d., an amount set aside in previous periods in respect of depreciation of the s.s. *Investigator*, no longer required, making a total to the credit of revenue account of £30,908 8s. 11d. The expenses have amounted to £28,952 3s. 2d., leaving £1,956 5s. 9d. to be carried forward to the credit of next half-year's account. The falling-off in the amount of traffic receipts and subsidies has arisen from two causes, viz., the interruptions to the Company's cables, and the accumulation of breaks pending the despatch of the steamers *Grappler* and *Duchess of Marlborough* to replace the disabled steamers *Investigator* and *Caroline*. At the date of the last report nine cables were interrupted, and since that time four other interruptions have occurred. Nine of these have been successfully repaired, and the directors are glad to report that only one section is now interrupted which affects telegraphic communication, viz., that between Trinidad and Demerara. It is therefore hoped that the traffic will now revert to its normal proportions.

The following are the final quotations of telegraphs:—Anglo-American, Limited, 56½-57; Ditto, Preferred, 87-88; Ditto, Deferred, 28½-29; Black Sea, Limited, ——; Brazilian Submarine, Limited, 10⅛-10⅜; Consolidated Telephone Construction, 4s. 6d. to 5s. 6d. pm.; Cuba, Limited, 9-9½; Cuba, Limited, 10 per cent. Preference, 16½-17; Direct Spanish, Limited, 3¾-4¼; Direct Spanish, 10 per cent. Preference, 13-14; Direct United States Cable, Limited, 1877, 11⅛-11⅜; Scrip of Debentures, 101-104; Eastern, Limited, 9⅞-10⅛; Eastern 6 per cent. Preference, 12⅝-13; Eastern, 6 per cent. Debentures, repayable October, 1883, 103-106; Eastern 5 per cent. Debentures, repayable August, 1887, 103-105; Eastern, 5 per cent., repayable Aug., 1899, 105-108; Eastern Extension, Australasian and China, Limited, 11-11¼; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 109-112; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 105-107; Ditto, registered, repayable 1900, 105-107; Ditto, 5 per cent. Debenture, 1890, 100-103; Eastern and South African, Limited, 5 per cent. Mortgage Debentures, redeemable 1900, 103-106; Ditto, ditto, to bearer, 103-106; German Union Telegraph and Trust, 11¾-12¼; Globe Telegraph and Trust, Limited, 6¼-6½; Globe, 6 per cent. Preference, 12⅜-12⅝; Great Northern, 12⅛-11½; 5 per cent. Debentures, 103-106; Indo-European, Limited, 29-30; London Platino-Brazilian, Limited, 6⅛-6⅜; Mediterranean Extension, Limited, 2¼-2⅜; Mediterranean Extension, 8 per cent. Preference, 9¾-10¼; Oriental Telephone, ⅛ dis. to par; Reuter's Limited, 11-12; Submarine, 270-290; Submarine Scrip, 2⅛-2⅜; Submarine Cables Trust, 101-104; United Telephone Company, 7⅛-8⅛; West Coast of America, Limited, 4½-5; West India and Panama, Limited, 2-2¼; Ditto, 6 per cent. First Preference, 7-7½; Ditto, ditto, Second Preference, 6-6½; Western and Brazilian, Limited, 8⅛-8½; Ditto, 6 per cent. Debentures "A," 104-108; Ditto, ditto, ditto, "B," 98-102; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 104-108; Telegraph Construction and Maintenance, Limited, 31-31½; Ditto, 6 per cent. Bonds, 107-110; Ditto, Second Bonus Trust Certificates, 3¼-4; India Rubber Company, 20-21; Ditto, 6 per cent. Debenture, 105-109.

TRAFFIC RECEIPTS.

NAME OF COMPANY.		MARCH.	APRIL.	REMARKS.
		£	£	
Anglo-American...	1881	51,540	43,980	
	1880	*40,290*	*41,880*	
Brazilian S'marine	1881	15,762	15,538	
	1880	*13,379*	*15,525*	
Cie. Française ...	1881	...	...	Not published.
	1880	..	..	
Cuba Submarine ..	1881	3,100	3,100	Feb. estimated at £2,900, realised £2,867.
	1880	*3,686*	*3,139*	
Direct Spanish ...	1881	1,492	1,337	
	1880	..	*1,453*	
Direct U. States ...	1881	17,180	14,660	
	1880	*13,430*	..	
Eastern	1881	51,206	45,289	
	1880	*49,374*	*44,744*	
Eastern Extension	1881	29,661	26,746	
	1880	*26,435*	*24,342*	
Great Northern ...	1881	18,520	17,720	
	1880	*19,440*	*18,360*	
Indo-European ...	1881	...	...	Not published.
	1880	..	..	
Submarine	1881	...	...	Publication temporarily suspended.
	1880	..	..	
W. Coast America	1881	...	...	
	1880	*1,775*	..	
West. & Brazilian	1881	10,797	10,484	
	1880	*9,908*	*11,502*	
West India	1881	5,050	5,470	Dec. receipts realised £3,288, those for Jan. £4,332.
	1880	*6,559*	*4,535*	